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Fight the Pandemic

Highlights from the 2020 IEEE 5-Minute Video Clip Contest

The annual IEEE 5-Minute Video Clip Contest (5-MICC) was launched by the IEEE Signal Processing Society (SPS), and the selected topic for the competition at IEEE ICIP 2020 was "Fight the Pandemic." The organizing committee selected three finalist videos and placed them online for public voting. The first one is about a visual analytic system for pandemic management, the second concerns machine learning screening of coronavirus disease (COVID-19) patients based on X-ray images, and the third deals with a COVID-19 test strip reader. Taking the public voting results from more than 800 participants into consideration, the panel of judges decided the final rankings of the three videos. In this article, we present an overview of the 5-MICC at ICIP 2020, describing the competition setup, the teams, and their approaches. We also share our experience and the feedback we received from the finalists.

The topic

In the past year, the outbreak of the COVID-19 pandemic has disrupted the world as we knew it, endangering our health and, tragically, taking over 1 million lives worldwide. The disease has been a great equalizer, showing that we are all alike in sickness: in fragility, suffering, and grief. We have erected barricades to protect ourselves, but the pandemic has disregarded our defenses and united us all, and united we must battle it. There has been a tremendous global medical and pharmaceutical effort to subdue this disease by seeking accurate diagnostics, effective treatment, and reliable vaccines. At the time of this article's writing, a number of vaccines are undergoing final development stages, and schedules for their delivery to the most endangered sectors of the population have been announced. However, fighting COVID-19 is not only about medicine, but it is also about technologies and how they can contribute to combatting the pandemic. Many engineers, technicians, researchers, and scientists from our Society have participated in this fight (e.g., [1]–[8]). The developed technologies have addressed, for instance, the diagnosis of the disease [9]–[12]; identification and tracking of infected people and regions [13]; remote monitoring of patients; isolated, hospitalized patients' communication with people outside of the hospital; controlling the spread of disease [14]; and modeling of COVID-19 time-series data [15]. Novel solutions have been examined specifically to cope with the problems triggered by COVID-19.

When possible topics for the ICIP 2020 5-MICC were discussed, a resounding chorus was heard: "Fight the Pandemic." It was unanimously agreed upon to invite contributions that would present novel image and video processing approaches addressing any aspect that could help in fighting the COVID-19 pandemic. The submitted video could cover any role that image and video processing or related areas may play in the management of pandemics. Suggested topics were the detection of the coronavirus; identification and tracking of infected people or people with fevers in airports; image acquisition and processing for managing the pandemic; COVID-19 detection from chest X-rays and computed tomography images; new developments in medical diagnosis, treatment, and patient monitoring; and future directions for using image and video-processing tools for analysis modeling and understanding pandemics. The decision was made to also accept "open topic" video submissions dealing with image and video processing for medical applications, even if the submissions were not exclusively related to the pandemic. The rationale for this was to engage our very diverse community to put forward creative ideas. The open topic submissions

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would compete along with submissions under the "Fight the Pandemic" topic and would be evaluated by the panel of judges with the addition of experts in the submitted videos' open topic areas.

The contest

Since the 45th ICASSP (ICASSP 2020), the SPS, through the Student Services Committee, has organized the 5-MICC. The objective of this competition is to promote the creation of video clips that highlight and convey excitement about signal processing in the broad sense, which includes aspects such as image, video, audio, speech, communication, radar, language, knowledge, human and machine learning, and other forms of information bearing data and signals. After the great success of the first run of the 5-MICC at ICASSP 2020 [16], the initiative was extended to the ICIP. Of course, in the case of the ICIP, the topic of the competition has to be related to video and image processing.

There has been a tremendous global medical and pharmaceutical effort to subdue this disease by seeking accurate diagnostics, effective treatment, and reliable vaccines.

For each contest, the submitted videos focus on a particular topic that is selected from proposals received from IEEE SPS members and endorsed by one or more Signal Processing Technical Committees (TCs) or Working Groups, with the aim that the topic will promote the field in a compelling and effective manner. The SPS TC chairs vote on the submitted proposal to determine the contest topic. The video competition also accepts "open topic" submissions, even if they are not related to the year's selected topic. The video must be original and can neither have been published previously, nor published during the competition period. The video must be submitted in English or with English subtitles and can only be submitted once. The rationale for this is to engage the broader signal processing community to put forward creative ideas. Open topic submissions will compete along with all yearly topic submissions.

The technical organizing committee of the contest for ICIP 2020 consisted of six members of the IEEE TC for Signal Processing Theory and Methods, including Dr. Tirza Routtenberg (Ben-Gurion University of the Negev, Israel), Prof. Alberto Carini (University of Trieste, Italy), Dr. Emilie Chouzenoux (Inria Saclay, France), Prof. Piya Pal (University of California, San Diego, United States), Prof. Alejandro Ribeiro (University of Pennsylvania, United States), and Prof. Jose Bermudez (Federal University of Santa Catarina, Brazil).

The contest was open for submissions from IEEE SPS members, including undergraduate and graduate students of all majors as well as researchers from all over the world. It was decided that each team should be composed of 1) one faculty member (the supervisor), 2) one graduate student at most (the tutor), and 3) at least three but no more than five undergraduates. At least three undergraduate team members had to be either IEEE SPS student members or SPS members by the time they submitted the full 5-min video.

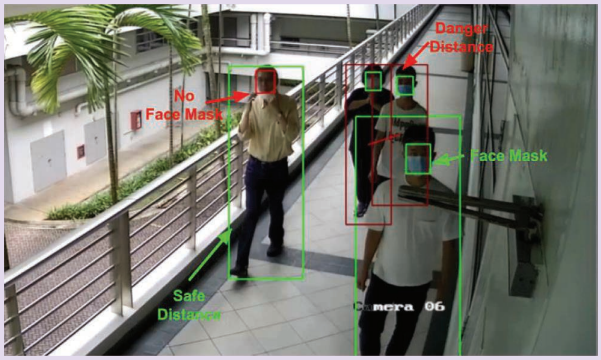
The call to the ICIP 2020 5-MICC consisted of three stages:

- *Submission of 30-s trailers*: The submission deadline was 30 August 2020. Each submission had to include a report in the form of an IEEE conference paper, up to two pages, on the main idea/concept of the full video that was submitted with the related written script. The selected best teams, once identified, were invited to send the final 5-min video to participate in the final competition.
- *Submission of the full 5-min video*: The submission deadline was 10 October 2020, and this stage culminated in the announcement of the three best videos on 16 October 2020. The three finalist teams were selected by the organizing TC.
- *The final contest*: The contest was held at the ICIP 2020 virtual conference in the United Arab Emirates (25–28 October 2020). It was decided that voting would continue until 23 October 2020. Then, the judging panel decided the final ranking, also taking into account the popular vote. The public votes cast for the three finalist videos included more than 800 votes from around the world. The judging panel discussed different aspects of the quality of the submissions, including the scientific content, methodology, presentation, graphical quality, and clarity.

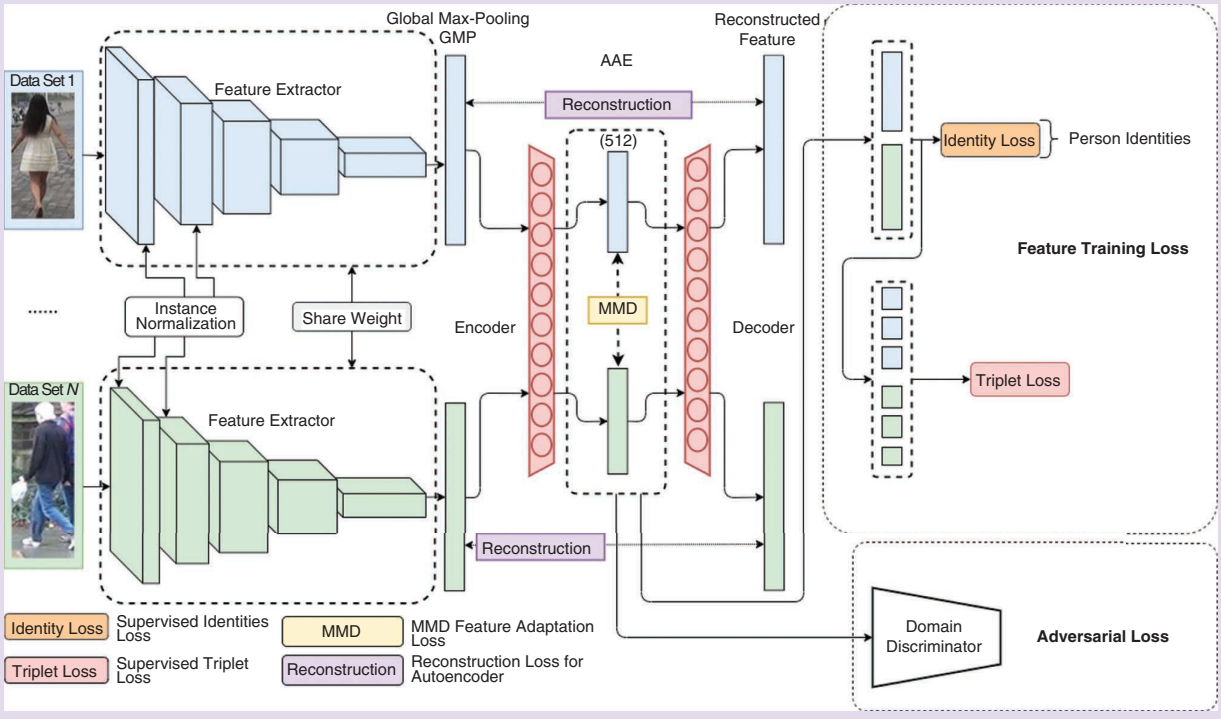
The finalists

The winners and final team rankings were announced during the conference. The finalist teams and their final rankings were as follows.

- "Visual Analytic System for Pandemic Management During COVID-19" (the winner)
  - *Affiliation*: Nanyang Technological University
  - *Students*: Shan Lin, Fu Long Tan, Chen Hongyu, Kuan Yang Tang, Yingtian Tang, and Nemath Ahmed
  - *Supervisor:* Prof. Alex Kot
  - *Technical approach*: The proposed visual analytic system for pandemic management utilizes artificial intelligence models to address two critical problems in the monitoring and managing of the disease: 1) the attire of a face mask and social distancing management and 2) the surveillance and movement path tracing of individuals. By using face detection, pedestrian detection, and face mask classification models, the system can proactively monitor the area and raise an alarm when detecting either social distancing violations or people without face masks. The surveillance and path tracing functions were developed based on the Multitask Midlevel Feature Alignment with Adversarial Auto-Encoder (MMFA-AAE) person reidentification models. The MMFA-AAE model aims to learn a well-generalized, universal



(a)



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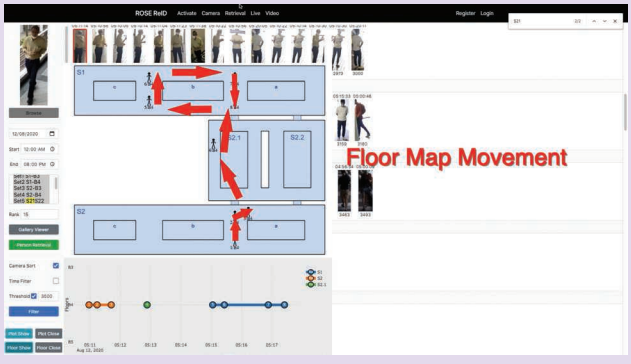

(c)

FIGURE 1. The video for the "Visual Analytic System for Pandemic Management During COVID-19": (a) identifying people with/without face masks and safe/dangerous distancing, (b) an overview of the MMFA-AAE framework for person reidentification multidomain generalization, and (c) floor map movement tracing. GMP: global max-pooling; MMD: maximum mean discrepancy.

representation of pedestrians in any unseen system. It alleviates the domain difference via adversarial training and also matches the distribution of the midlevel features across multiple data sets. With the help of the MMFA-AAE models, quick searches can be performed. The proposed visual analytic system enables 24/7 monitoring and delivers actionable intelligence with in-depth insights to combat the spread of COVID-19. The technical approach is demonstrated in Figure 1.

- "Machine Learning Screening of COVID-19 Patients Based on X-Ray Images for Unbalanced Classes" (second place)
  - *Affiliation*: Qatar University
  - *Students*: Ilyes Mrad, Hatem Jebari, and Amine Ghattasi
  - *Supervisor*: Prof. Ridha Hamila
  - *Technical approach*: The efficient detection of infected patients is a key phase in the battle against COVID-19. Standard chest X-Ray images aid to detect suspected cases at an early stage. However, the images of different viral cases of pneumonia are typical and overlap with other inflammatory lung diseases. The goal of this approach is to use chest X-ray images to detect COVID-19 pneumonia patients while optimizing detection efficiency. The group proposes a deep convolution neural network-based transfer learning approach to automatically identify COVID-19 cases using an unbalanced data set of chest X-ray images. The fundamental challenges to solve are 1) how to design a model that can detect COVID-19 cases without any human supervision; 2) how to deal with the unbalanced data set, especially with the low number of COVID-19 samples; and 3) how to improve a model that has already produced a good performance in terms of accuracy and sensitivity. The proposed model combines three techniques: "convolution neural network," "transfer learning," and the "focal loss function" to build three binary classifiers, which are "COVID-19 Versus Normal," "COVID-19 versus pneumonia," and "COVID-19 Versus Normal Pneumonia (Normal and Pneumonia)." The focal loss is aimed at addressing the scenario of object detection where there is a radical imbalance between classes. The performances of different networks were evaluated utilizing five metrics, which are the average accuracy, sensitivity, specificity, precision, and F1-score, using 10-fold cross validation. Some challenges tackled by the proposed method are presented in Figure 2.

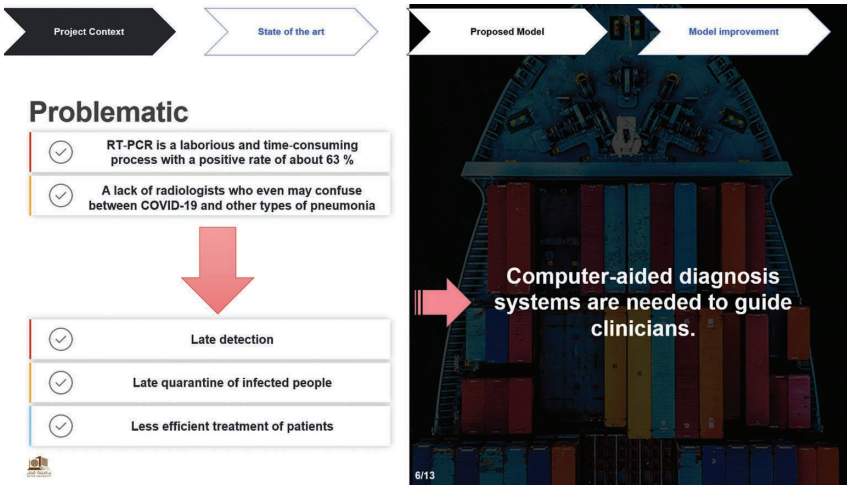

FIGURE 2. The "Machine Learning Screening of COVID-19 Patients Based on X-Ray Images for Unbalanced Classes: Project" overview. RT-PCR: reverse transcription polymerase chain reaction.

- "COVID-19 Test Strip Reader" (third place)
  - *Affiliation*: Nanyang Technological University
  - *Students*: Annan Wang, Xinyu Wang, and Rui Li
  - *Tutor*: Jingwen Hou
  - *Supervisor*: Prof: Weisi Lin
  - *Technical approach*: This project aims to provide an automatic tool for reading the results from images of COVID-19 test strips. There are two essential problems to be solved. First, the likelihood of infection is hard to quantify merely from the gray-scale intensities of test bands, due to illuminance variation. Thus, the proposed approach quantifies the likelihood of infection by the ratio of the gray-scale intensity of the test band to that of the control band, and, hence, the gray-scale intensity can be automatically extracted by the proposed method. Second, the test band and control band need to be accurately detected for correct readings. Therefore, inspired by the quick response code, the robust detection of test bands and control bands is realized by taking advantage of a positioning template with position markers. Each test strip is associated with a predefined positioning template. By taking a picture of a test strip that is correctly placed on the positioning template, the proposed image processing algorithm can robustly detect the position markers and accurately locate the diagnostic signals (i.e., test band and control band) on the test strip to compute the viral load. An example of the proposed approach is presented in Figure 3.

Summary

As a new event launched by the SPS, the 5-MICC has proved to be a success in terms of public engagement, as

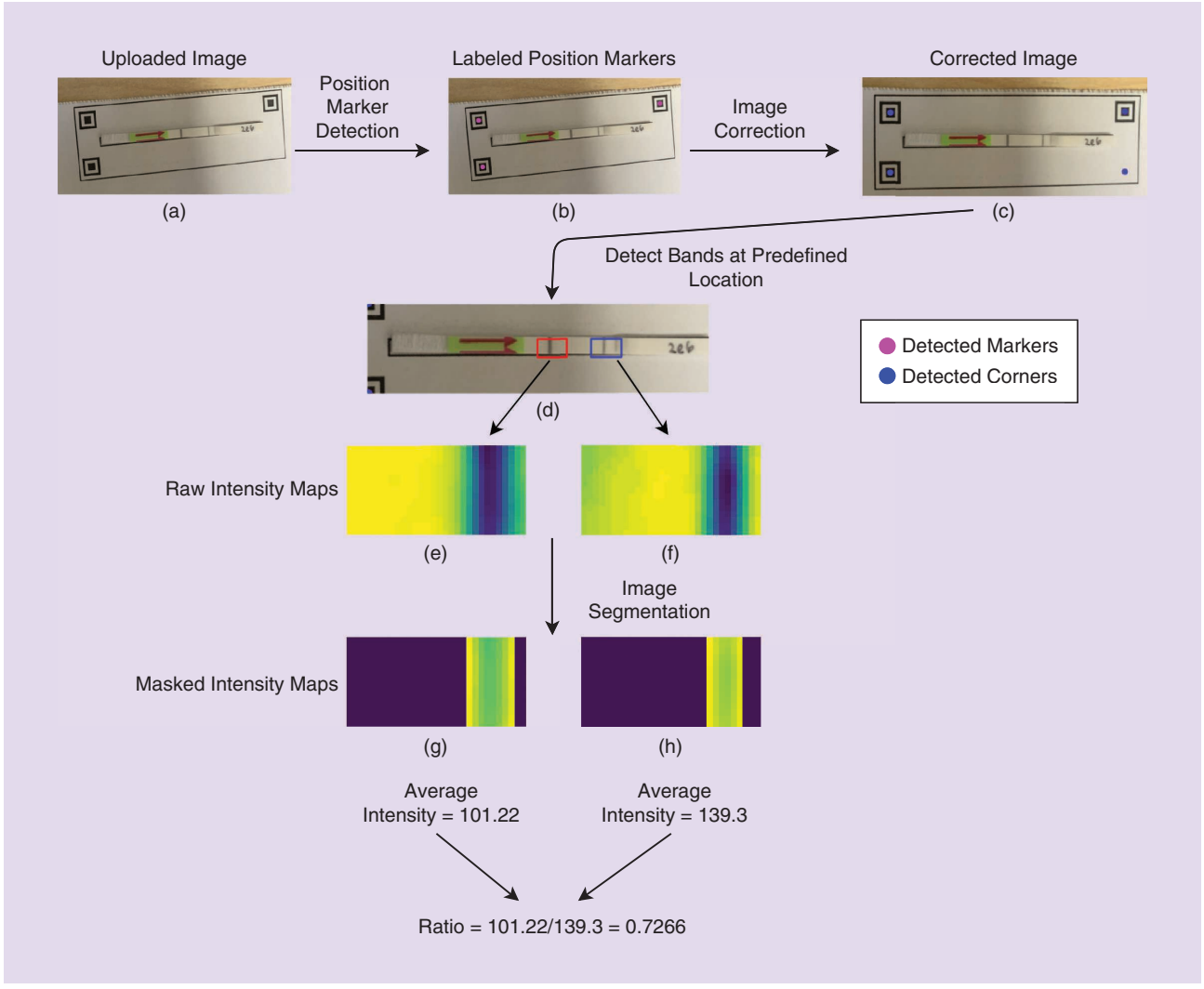

FIGURE 3. The "COVID-19 Test Strip Reader" schematic example of the detection process: (a) uploaded image, (b) labeled position markers, (c) corrected image, (d) detected bands at predefined location, (e) and (f) raw intensity maps, and (g) and (h) masked intensity maps.

seen from the large number of public votes cast for the three finalist videos. Due to the COVID-19 pandemic, the contest was virtual. The topic of this contest was chosen as part of our research community's effort for the public good and as part of the SPS vision: "being intimately involved in the education of signal processing professionals at all levels." When organizing a novel 5-MICC, organizers should take into consideration the time required for preparing for the submission and advertising. The 5-MICC has been highly appreciated by our community, and we look forward to more contests next year, at ICASSP 2021.

Acknowledgments

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